METHOD AND APPARATUS FOR TRANSMITTING INFORMATION REGARDING THE SYNCHRONIZATION STATUS OF A BASE STATION

FIELD OF THE INVENTION

The present invention relates generally to cellular communication systems and, in particular, to a method and apparatus for transmitting information regarding the synchronization status of a base station.

BACKGROUND OF THE INVENTION

Existing direct sequence spread spectrum cellular communication system protocols require base stations within the communication system to be time synchronized. For example, within a wireless communication system utilizing a Code Division Multiple Access (CDMA) system protocol, it is desirable to have all base stations within the communication system synchronized to +/−3 microseconds (μs), and it is mandatory that all base stations within the communication system be synchronized to at least to +/−10 μs. Synchronization occurs within a CDMA system as described in "Personal Station-Base Station Compatibility Requirements for 1.8 to 2.0 GHz Code Division Multiple Access (CDMA) Personal Communication Systems" (American National Standards Institute (ANSI) J-STD-008). In particular, all base stations reference a common CDMA system-wide time scale that uses Global Positioning System (GPS) time. All base stations utilize the same pseudo-noise (PN) spreading code (long code), but with different time offsets. A remote unit uses a correlator to detect the presence of the PN code, and will detect all base stations in the geographic region if it searches the entire length of the single PN code. In the described system, the base stations are offset from each other by integer multiples of 64 PN chips, thus allowing 512 unique offsets of the length 2^{15} or 32,768 chips. A major advantage in having all base stations within a communication utilize a common system time, is that when acquiring a base station, the remote unit only need to look within a very small time window around a nominal PN offset to acquire the new base station.

Since GPS is not visible everywhere (i.e., subways and dense urban environments), and to reduce the backhaul costs, some current CDMA developers are proposing that base stations within next-generation CDMA systems be unsynchronized. An example of an unsynchronized next-generation CDMA system is that proposed in "Fast Cell Search Algorithm in DS-CDMA Mobile Radio Using Long Spreading Codes" by K. Higuchi et al., VTC-97, pp. 1430–1434. In this proposal, all base stations operate in an unsynchronized fashion, each having a unique long code and a common short code. The base station primarily transmits a product of the two codes, but at defined times will mask the long code and transmit only the short code. Thus a remote unit may search for the common short code and get a periodic strong match from a strong base station, and a periodic weaker match from a weaker base station. Higuchi et al. describes a process for the mobile to first detect short codes, then determine the long code phase, a long code group identification, and then the long code identification along with the frame timing. A mobile in communication with one base station must continually search for the presence of nearby base stations using this same process, since all base stations within the system are unsynchronized and cannot communicate timing information to the remote units to reduce their search. Because of this, remote units handing off within an unsynchronized system will need to look within a larger code space to acquire a new base station. Since there currently exists no method to determine whether a communication system is synchronized or not, remote units handing off within next-generation CDMA systems will be required to search a larger code space (for asynchronous base stations) and time window (for synchronous base stations) when handing off, even if the base stations are time synchronized, resulting in unnecessarily long handoff times.

It is desirable to have synchronized base stations for fast acquisition, yet allow the system to operate in geographic areas where accurate time synchronization is unavailable, or continue to operate when time synchronization fails. In order to accomplish this task, a remote unit must know beforehand whether a particular base station is operating in a synchronized or an unsynchronized mode so that the remote unit can vary its searching technique accordingly. Therefore, a need exists for a method and apparatus for transmitting information regarding the synchronization status of a base station to a remote unit so that the remote unit can vary its searching technique accordingly.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a wireless communication system in accordance with the preferred embodiment of the present invention.

FIG. **2** is a block diagram of a base station of FIG. **1** in accordance with the preferred embodiment of the present invention.

FIG. **3** is an illustration of signals transmitted from a base station of FIG. **1** in accordance with the preferred embodiment of the present invention.

FIG. **4** is a flow chart showing operation of the base station of FIG. **1** in accordance with the preferred embodiment of the present invention.

FIG. **5** is a flow chart showing operation of the remote unit of FIG. **1** in accordance with the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Stated generally, base stations within a communication system utilize a spreading code that is dependent upon whether the particular base station is operating in a synchronized, or an unsynchronized mode. Unsynchronized base stations within the communication system utilize a long code unique to the particular base station, and base stations operating in a synchronized mode utilize a time shifted version of the same long code. To reduce the search time for remote units within the communication system, a group identification code (GIC) is broadcast during a time period that the long code is masked by a common short code. The GIC is selected from a subset of 64 ary Walsh code or Orthogonal Gold code. The GIC indicates a long code (spreading code) group to which the long code of each base station belongs. Additionally, each base station within the communication system determines its synchronization status and utilizes a particular GIC and long code based on the base station's synchronization status. By analyzing GIC information, remote units acquiring base stations know beforehand whether a particular base station is operating in a synchronized or an unsynchronized mode, and can vary their searching algorithm based on the base station's synchronization status. This allows remote units to operate with synchronized base stations yet be able to operate in geographic areas where accurate time synchronization is unavailable, or continue to operate when time synchronization fails.